development of the remarkable instrument which has superseded the far more ancient organ, and which has become the domestic companion and indispensable accessory in thousands upon thousands of households throughout the civilised world.

Probably no man living knows so much about the pianoforte as Mr. Hipkins: attached for many years to the honoured house of Broadwood and Sons; almost able to remember its original title of Tschudi and Broadwood, which carries us back at one bound to the epoch of the harpsichord Mr. Hipkins is not only an experienced musician, but an excellent physicist in his special line. He has read valuable papers before the Royal Society, and efficiently co-operated with Mr. Alex. Ellis in his laborious determinations of pitch and of oriental or archaic musical scales.

The somewhat neglected subject here given with the terseness and accuracy of a monograph, as is proper in a work somewhat of the nature of an index, is the mechanical development of the modern pianoforte from the earliest form of keyed instrument with strings, shown in a drawing by Miss Edith Lloyd of a sculpture in St. Mary's Church, Shrewsbury belonging to the first half of the fifteenth century. Besides this and other woodcuts of typical instruments, is a series of diagrams showing the various forms of "tangent," "jack," "hammer," "action," and "escapement" by which the sounding string has been successively made to vibrate with ever increasing fulness and beauty of tone and quality. Towards the end of the article the recent substitution of metal for wooden framings is similarly summarised and illustrated. No doubt much of this would be hard reading for an unmechanical student; but it was really needed, and as a compact whole could hardly be said to exist previously.

The early part of the article appeals to every reader, and is full of fascinating and original research. There are eleven other capital woodcuts besides that named above of clavichords, clavicymbalums, spinetts, and clavicytheriums, which, under a multiplicity of names, preceded the four "gravicembali col piano è forte," which Cristofori, the Paduan harpsichord maker had, on the undoubted authority of the Marchese Scipione Maffei, completed in the year 1709. This date may be looked on as the birthday of the name and the instrument. Originally adjectival and explanatory, it has been adopted substantivally wherever this ubiquitous form of the "dulcimer with keys," as Mr. Hipkins quaintly defines it, has penetrated.

BALL'S "STORY OF THE HEAVENS"

The Story of the Heavens. By Robert Stawell Ball, LL.D., F.R.S., Royal Astronomer of Ireland. (London, Paris, New York, and Melbourne: Cassell and Co., Limited, 1885.)

POPULAR works on astronomy, either on its entire range or selected portions, have been so numerous of recent years as to make it difficult to judge a new one entirely on its own merits; it is felt that there must be some well-marked originality of plan or execution, some novelty of treatment, or freshness of fact, to justify an addition to an already abundant literature.

The present work can urge its claim to a favourable reception on a twofold ground; it is the fullest and most complete exposition of the leading facts and principles of astronomy which has yet been laid before the entirely unscientific public, and it devotes special attention to some of the most recent and interesting astronomical discoveries. It is in no sense whatsoever a student's book, but aims to give, in such simple and untechnical language as may be most acceptable to the general reader, a comprehensive view of the results of astronomy as at present received. So thoroughly is it elementary in character that Dr. Ball from time to time seems to think he has a childish audience before him, and descends to a style which is nowadays considered almost too condescending to be addressed even to children. Thus, in speaking of the distance of the sun, he says (p. 28):—

"The actual distance of the sun from the earth is about 92,700,000 miles; but merely reciting the figures does not give a vivid impression of the real magnitude. 92,700,000 is a very large quantity (*sic*). Try to count it. It would be necessary to count as quickly as possible for three days and three nights before one million was completed; yet this would have to be repeated nearly ninety-three times before we had even counted all the miles between the earth and the sun."

But though Dr. Ball may sometimes resort to this infant-school style he never falls into the opposite fault of being turgid or obscure. His language is always clear and distinct, and when treating of the particular subjects most congenial to him he usually succeeds in avoiding the fault we have just noticed, and his style leaves nothing to be desired.

In a brief introduction Dr. Ball indicates the principal questions which it is the business of the astronomer to seek to answer, and glances at some of the most important discoveries made by the ancients, concluding with the labours of Copernicus. The main volume then commences with a chapter on the astronomical telescope. The Dunsink South equatorial, the great Vienna refractor, and Lord Rosse's 6-foot reflector are described, and illustrations given of them; the Paris meridian circle is represented as a type of meridian instruments, and a well-written page (p. 22) is devoted to drawing a contrast between the ideal instrument and the actual one.

A number of chapters on the different members of the solar system follow. These occupy more than half the volume, and do not call for much special comment, for, whilst travelling over such well-trodden ground, there is but little scope for original treatment. The author throughout gives a clear matter-of-fact account of what he has to describe; there is never for a moment any difficulty in following his meaning, and for a work of this character this is a first essential. The chapter on the Sun is perhaps the least successful. Dr. Ball considers that it is not proved that "sun-spots are really depressions in the surface"; a statement which may be perfectly correct if "proved" is to be taken in its hard mathematical sense; but it ought to be supplemented by the further one that the entire evidence is in favour of that supposition. No reference is made to the frequently-repeated coincidences of solar outbursts and magnetic disturbances which were observed in 1882 and 1883, and which placed the connection of the two orders of phenomena in such a striking light. And again with reference to the spot-cycle, the nature of the cycle is rather crudely stated, and one of its most curious

features—the change of latitude in the *locale* of the spots—is altogether unnoticed. Chapter III., on the Moon, contains a little sketch-map of the moon and descriptions of the most striking formations. The laws of eclipses, the use of the moon in navigation, and Nasmyth and Carpenter's theory of the volcanic origin of the lunar craters are treated of with the author's usual clearness and at considerable length. In the concluding paragraphs Dr. Ball expresses his belief that forms of life unknown to us may probably exist on many of the celestial bodies, and applies to the question of the plurality of worlds the lines of Tennyson :—

"This truth within thy mind rehearse,
That in a boundless universe
Is boundless better, boundless worse."

The fourth chapter deals with the solar system as a whole, with the detection and identification of planets, with the positions and dimensions of their orbits and their own comparative sizes. It is followed by a chapter on the Law of Gravitation, a most important one, and admirably written. The law of gravitation is so important in itself, and so little understood by the unscientific portion of the public, that such an explanation as is here supplied is much needed.

The succeeding chapters deal with the planets one by one, beginning with Vulcan, the "Planet of Romance," which Dr. Ball is inclined to believe was really seen by Prof. Watson during the total solar eclipse of 1878, on the not unreasonable ground that an observer of his experience and skill was not likely to have been mistaken. In the chapters on the other planets the points to which most attention has been paid are the descriptions of the various modes of determining the sun's distance, and the size, form, and weight of the earth. There is a pleasing and somewhat full biography of the elder Herschel in the chapter on Uranus, and the wonderful story of the discovery of Neptune is told again in a fresh and engaging style. Leaving the regular members of the solar system, we come to the comets and shooting-stars, and with these Dr. Ball begins to treat his subject in a somewhat more original manner, and there is very much to commend in these and the following chapters. Encke's comet, the evidence it affords as to a resisting medium, and its usefulness as a means of determining the masses of Jupiter and Mercury and the distance of the Sun, occupy a considerable space. Bredichin's theory of comet's tails is clearly explained. Dr. Ball is, however, scarcely correct in authoritatively classing the great comet of 1843 as a non-periodic one, and the similarity of its orbit to those of the great comets of 1880 and 1882 surely deserved a word of notice. In the chapter on shooting-stars he draws a sharp distinction between meteors and meteorites, and expresses his conviction that Prof. Newton was wrong when he spoke of a meteoric stone as having probably been part of a comet. He also broaches and supports by some ingenious reasoning the idea that meteorites are largely of terrestrial origin, and he points out that meteorites of iron are much less frequent than those of stone.

Chapter XVIII. is on "The Starry Heavens," and is especially commendable for the series of little diagrams in which the relative positions of the principal fixed stars are shown with admirable distinctness. Nothing can be easier than for the reader with this portion of the book in hand to make himself acquainted with the general configuration of the northern constellations. Several instructive points are well brought out in the two following chapters, but in Chapter XXI., on the Distances of the Stars, we find Dr. Ball on ground which he has largely made his own. Herschel's attempt to form a conception of the distribution of the stars in space is clearly explained, and made the basis of a detailed description of the method of determining the distance of a star by its annual parallax, and the cases of 61 Cygni, α Centauri, and Groombridge 1830 are dealt with at considerable length. The difficulties of parallax work are sympathetically described, and the drawback often experienced of a long series of observations failing to show any parallax at all is made the occasion for enlarging on a particular instance of such a failure, viz. Nova Cygni, 1876. The chapter concludes with an explanation of Herschel's discovery of the motion of the solar system towards the constellation Hercules. The spectroscope is much more sparingly dealt with, and the entire range of astronomical spectroscopy is despatched in one of the shortest chapters in the book. It is not possible that so condensed an account should be very thorough or complete, but, given the necessity to confine the subject within these limits, it is difficult to see how it could have been much better done.

The three following chapters deal with Star Clusters, and Nebulæ, Precession and Nutation, and the Aberration of Light. Each of these subjects is well handled; the explanations of the three kinds of apparent motion shown by the stars being clearly and carefully explained, without going into any details which would be likely to prove too abstruse or tedious for any ordinary reader. The chapter on Nebulæ is illustrated by three plates, one of which, Trouvelot's drawing of the Great Nebula in Andromeda, is very well executed.

The two concluding chapters are of especial interest. Chapter XXVI., on "The Astronomical Significance of Heat," deals with the most important points in the history and method of the evolution of the solar system; the presence of heat in the body of the earth, the law of cooling, the heat of the sun and its possible sources, the doctrine of energy, the nebular theory and the evidence which supports it. With respect to this last it should be observed that the old illustration of the trees in the forest is by no means very apposite. Dr. Ball is, however, careful to distinguish such a theory, however magnificent and attractive, from the truths of astronomy properly so called.

From nebular evolution we pass naturally to tidal evolution. It is but comparatively recently that Dr. Ball's lecture upon this subject was reported in these pages, so that it is only necessary to say that the romantic story is well told this second time. The criticisms to which the theory was subjected are not referred to here, though some deserved greater consideration than to be silently passed over.

As we have already said, this is in no sense whatsoever a student's book. Dr. Ball has already shown how well qualified he is to produce such a work when he desires to do so, but he has had an entirely different purpose here. It may be doubted whether he has not in some instances been too general and undefined in his mode of treating

his subject; the explanation of the principles and methods involved in the determination of the sun's distance by means of Transits of Venus, for example, is particularly meagre and unsatisfactory. The public that does not care to have to exert much thought over its reading is not the public that will purchase books on astronomy 550 pages in length; an occasional light article in a magazine will satisfy its utmost craving.

Nevertheless a book which in a lucid and easy style supplies accurate and the latest information as to the methods and discoveries of astronomy, which is written by a competent authority, and which, if not profusely illustrated, is supplied with plates and woodcuts which leave no important object unrepresented, no fundamental argument unsupported, can only be spoken of as a good one; and those who wish to possess a full, interesting, and popular account of the present state of the most noble and enthralling of all the sciences cannot do better than make themselves possessors of the "Story of the Heavens."

OUR BOOK SHELF

Annual Report of the Board of Regents of the Smithsonian Institution for the Year 1883. (Washington: Government Printing Office, 1885.)

THIS is the most bulky, and perhaps the most valuable, of these well-known Reports; it consists of very nearly 1000 pages, and we learn, from the resolution of Congress which precedes it, that 16,060 copies have been printed. The more strictly official part of it deals with the Smithsonian Institution and the Natural History Museum, including the Report of the Committee on the Henry statue recently erected in the grounds; but, besides these, we have Reports on the various branches of science, so valuable that no scientific library should be without them. Astronomy has been taken in hand by Prof. Holden, the newly-appointed Director of the Lick Observatory; meteorology, by Mr. Cleveland Abbe; physics, by Prof. Barker; zoology, by Prof. Guild; and anthropology by Mr. Otis T. Mason, the latter covering nearly 200 pages. Other branches of science besides those which we have named are reported at less length.

When we consider the importance of these *résumés*, and the fact that 7000 copies of the volume are being distributed gratuitously by the Institution all over the world, we may readily concede that in this, as in their other duties, the Regents of the Institution are faithful to the trust imposed upon them by Smithson to promote the increase and diffusion of knowledge among men.

The Sun: a Familiar Description of His Phenomena. By the Rev. Thomas William Webb, M.A., F.R.A.S. (London: Longmans, 1885.)

THIS is a little book of seventy-eight pages, containing what appears to have been a lecture given by the author, who, to the great loss of observational astronomy, died a short time ago. That part of it which deals with the telescopic facts is very much more in harmony with our present knowledge than that smaller part of it which deals with the revelations of the spectroscope. The whole is very charmingly and simply written.

Notes on the Physiological Laboratory of the University of Pennsylvania. By N. A. Randolph, M.D., and S. G. Dixon. (Philadelphia, 1885.)

THIS little volume consists of a series of short papers giving the results of practical investigations into the behaviour of certain substances, such as starch, cod-liver oil, boiled and unboiled milk, &c., when used as articles of food by infants and adults. Many of the papers are of interest; all of them show evidence that in the University of Philadelphia, physiology is not taught as a matter of book-learning, but that the students are instructed in the practical bearings of the science.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to insure the appearance even of communications containing interesting and novel facts.*]

Lieutenant Greely on Ice

I HAVE read with deep interest the graphic but brief account of Lieut. Greely's Arctic explorations given in NATURE of November 26 (p. 90), and also in some of the Scottish papers, which touch upon subjects not mentioned in NATURE.

Assuming that these reports are, in all material points, correct, I ask leave to be permitted to offer some remarks on a few of the opinions expressed by the distinguished explorer, the correctness of which seems open to question.

Before doing so, however, I would draw attention to the very considerable difference in the mean yearly temperatures at Discovery Bay, as given by the English Government ship that wintered there in 1875-76, and that of Lieut. Greely wintering at the same place six or seven years later.

Capt. Stephenson, H.M.S. *Discovery*, 1875-76 ...	−4°·23 F.
Lieut. Greely, in house six or seven years later, about	+4°·00
Making a difference of	8°·23

I suppose the thermometers to be in both cases correct, and the mean temperatures computed in the same manner in each case. In saying that "Grinnell Land has the lowest mean temperature in the globe," surely Lieut. Greely goes a little too far, as no observations have elsewhere been made in so high a latitude, nor at any point in the great circle of 1100 miles' diameter *nearer* to the Pole than Discovery Bay, in nearly all parts of which it would be a very natural conclusion to arrive at, that the mean temperature would be lower. Lieut. Greely adds, "This" (the lowest temperature in the globe) "was in accordance with their expectation."

Kane went to the Arctic Sea with "expectation" and a belief that he would find an open Polar sea! His steward, Morton, conveniently found it for him, and it was *believed* in for a time, until other expeditions passed the place where "Morton's pool" of open water had been seen; but alas! not a trace of it could be found, although ships had gone by, creeping along shore, some hundred miles further north. The distinguished Greenland explorer Rink, finally, effectually demolished this Arctic dream. Lieut. Greely's open Polar sea of 1100 miles' diameter round the Pole seems to be a myth of a somewhat similar kind. It is purely a theory, with facts, to my mind, adverse to its probability; for why this immense body of water in the far north, whilst constantly sending forth great ice-streams southward through the broad inter-Greenland-Spitzbergen Channel, should be itself ice-free, whilst other seas far southward, having a much higher temperature, and probably with currents and gales of wind at least as strong, are ice-encumbered, is rather difficult to understand.

As regards floebergs, Lieut. Greely has advanced their size and thickness far beyond anything one would infer from reading the narrations of the English Expedition of 1875-76, which first gave the name to those curious masses of ice. He has not only done this, but he attributes their formation to a source which completely destroys the meaning of the name "floeberg," used in contradistinction to "iceberg," to show that the former has its origin from the floe or sea ice, instead of from ice formed on land, and is either built up by the gradual increment of the floe and the snow that falls upon it, or, as I believe more likely, by a number of floes being forced by immense pressure one over the other, until great thickness is attained. Perhaps the best example of a floeberg (according to my idea) that I can give, is that which lifted the ship of the Austrian Expedition seventeen feet (I think) out of